A METHODOLOGY FOR THE OPEN LOOP CALIBRATION OF A DEFORMABLE FLAT PLATE ON A 70-METER ANTENNA

David J. Rochblatt, Daniel Hoppe, Manuel Franco, William A. Imbriale, Paul Richter, Phil Withington, Herschel Jackson

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive, Pasadena California 91109
david.j.rochblatt@jpl.nasa.gov

Abstract:

This paper describes an experimental study of a deformable flat plate (DFP) on the NASA-JPL 70-meter antenna located at Goldstone California at Ka-Band (32-GHz). The main purpose of the DFP is to compensate for the gain loss of the 70-meter antenna due to gravity induced structural mechanical deformations to its main reflector surface. At Ka-Band these losses were measured to be 2.5 and 6.5-dB respectively at low and high elevation angles. A novel method for the open loop calibration of a DFP leading to successful gravity compensation over all elevation angles is described. At elevation angles of 10- and 80-degrees, compensations of 1.25 and 3.0-dB at Ka-Band were achieved.

The open loop calibration of a DFP utilizing 16 actuators was achieved by deriving the gravity deformation of the antenna at all elevation angles from holographic measurements at the three elevation angles of 47.2, 36.7, and 12.7-degrees, and performing a ray trace from the deformed main reflector to the DFP position. The beacons of three geostationary satellite GSTAR-4, GE-2, and INTELSAT 706 were used as far-field signal sources for the three elevation angles respectively at Ku-Band (11-13 GHz). The JPL microwave antenna holography system (MAHST) was used to measure the antenna far-field complex function from which the antenna effective surface deformations were derived. To overcome the difficulty of not having an observable geostationary satellite above 47-degrees elevation, the following assumptions were made in the computation of the surface deformation function:

1. The antenna structural response due to gravity loading is linear.
2. The elevation rigging angle of the antenna can be accurately inferred from total power radiometry (TPR) efficiency measurements.
3. The antenna response to gravity loading is symmetric relative to the antenna elevation rigging angle.

The derivation is based on computing two loading vectors of the total antenna effective deformation in the positive Y- and Z- axis directions. The loading vector Y represents the total antenna deformation when the antenna elevation angle is 0-degrees, and the vector Z represents its total deformation at 90-degrees. The antenna deformation was computed at 5-degree increments in elevation and then ray traced to the DFP position to compute the displacements of the 16 actuators and thus derive its look-up table.